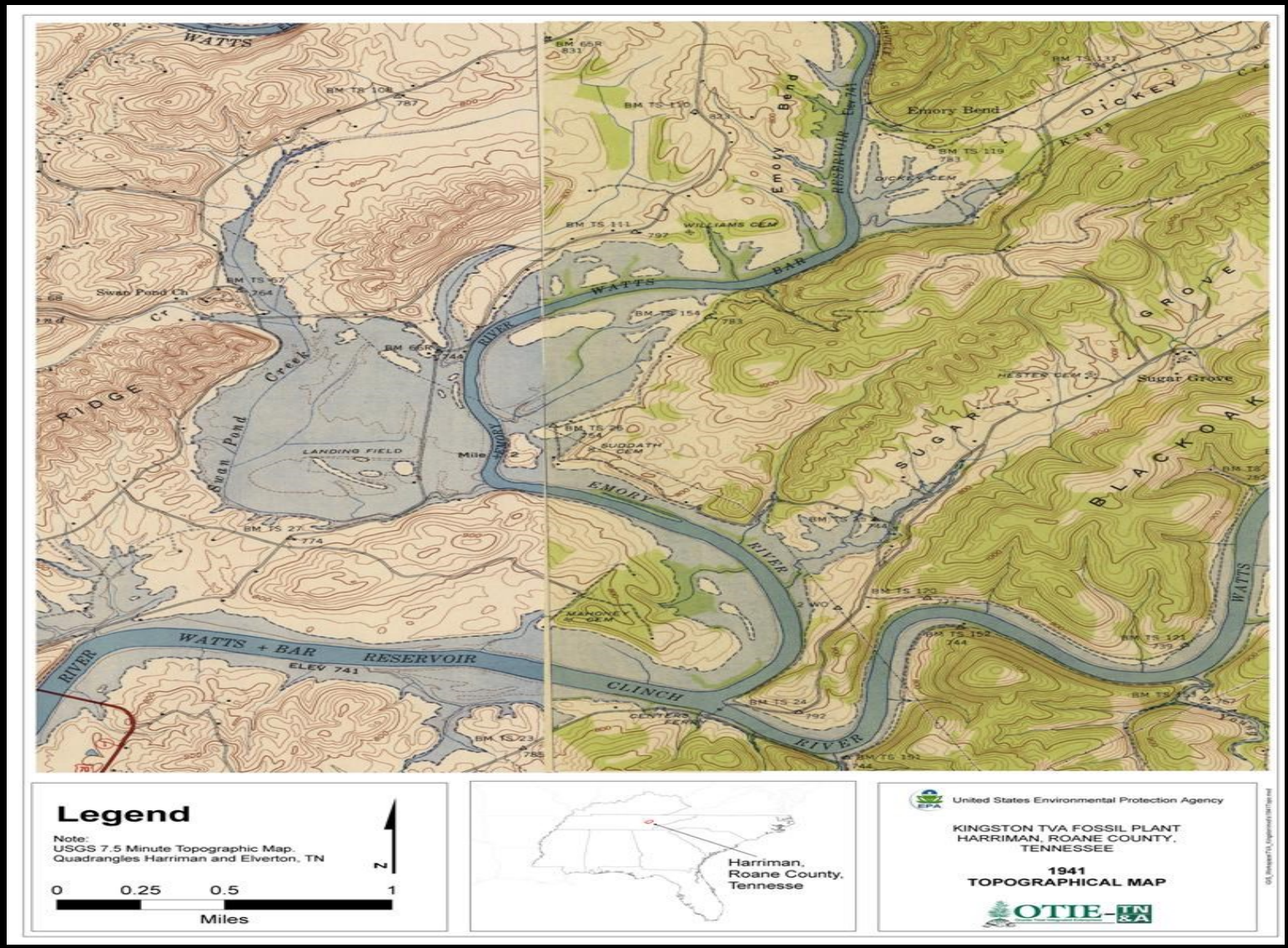
TVA Kingston Ash Recovery Project
Roane County, TN

Craig Zeller, P.E.
Remedial Project Manager
Superfund Division
US EPA Region 4
Zeller.Craig@epa.gov

TVA Kingston Steam Plant

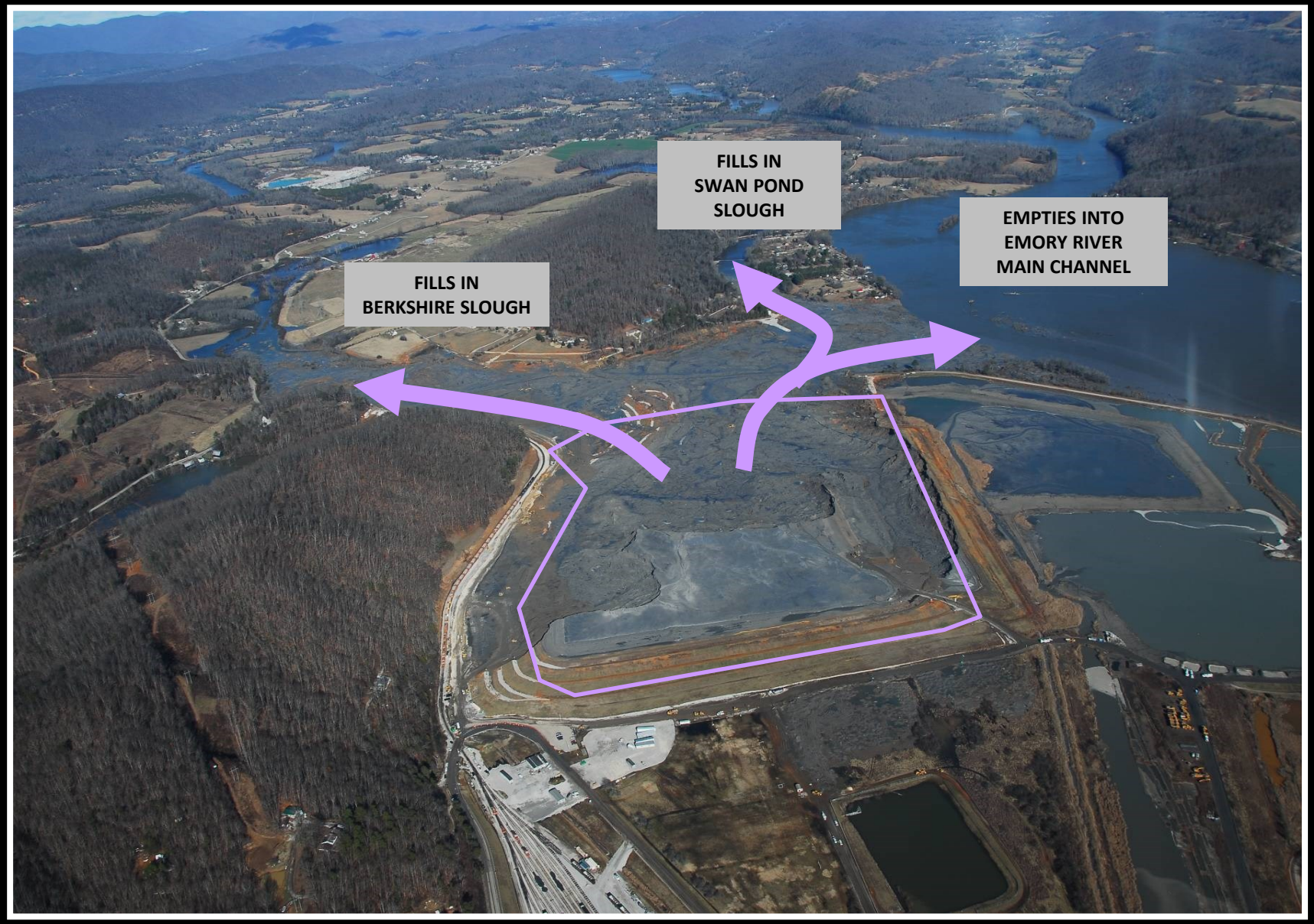
- ≈ 30 miles west of Knoxville off Interstate 40
- Emory River Mile 2.0 (just above confluence with Clinch River)
- Built 1951 to 1955 (initially for DOE Oak Ridge Reservation)
- 9 coal fired units
- 10 Billion KW-Hrs electricity year (670,000 homes in TN Valley)
- 14,000 tons of coal day (10% coal ash recovered)

Swan Pond Embayment 1941



Dredge Cell Area Pre-Spill

Spill Progression – 12/22/08



Dredge Cell Area Post-Spill

Root Cause Analysis

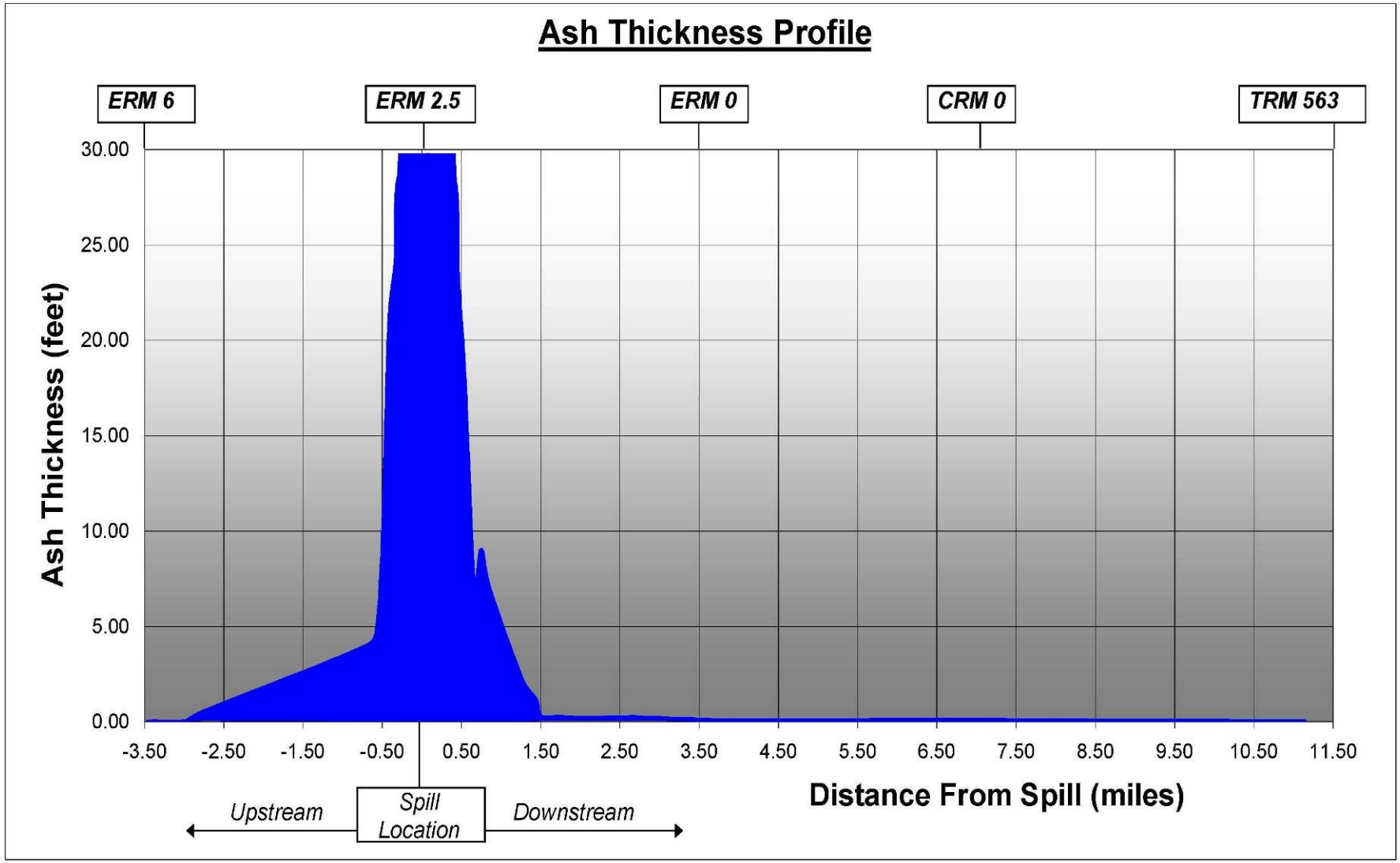
Kingston Dredge Cell Failure Conditions

CERCLA Removal Action Strategy

(May 12, 2009 AOC)

- **Phase 1 (Time-Critical Action Removal)**
  - 3.5 million cys removed (excavated and dredged)
  - 4.0 million tons disposed at Perry County, AL (completed 12/01/10)
  - May 29, 2010 Emory River reopened
- **Phase 2 (Non-Time Critical Action Removal)**
  - 2.8 million cys to be removed (north and middle embayment)
  - Consolidate in reinforced, on-site disposal area
  - Construct robust subsurface perimeter containment system to withstand earthquake loads
- **Phase 3 (Residual Ash Study)**
  - River ecosystem and human health risk assessments
  - Long-term monitoring (5-year reviews)

Ash Deposition (Pre-Dredging)



Ash vs. Native Soil Concentrations

(volume = 3M cys)

(Ash) Element	Avg. ppm	Est. lbs.
Aluminum	22,700	177 million
Iron	17,961	140 million
Copper	59	462,000
Arsenic	66	515,000
Selenium	6	51,000

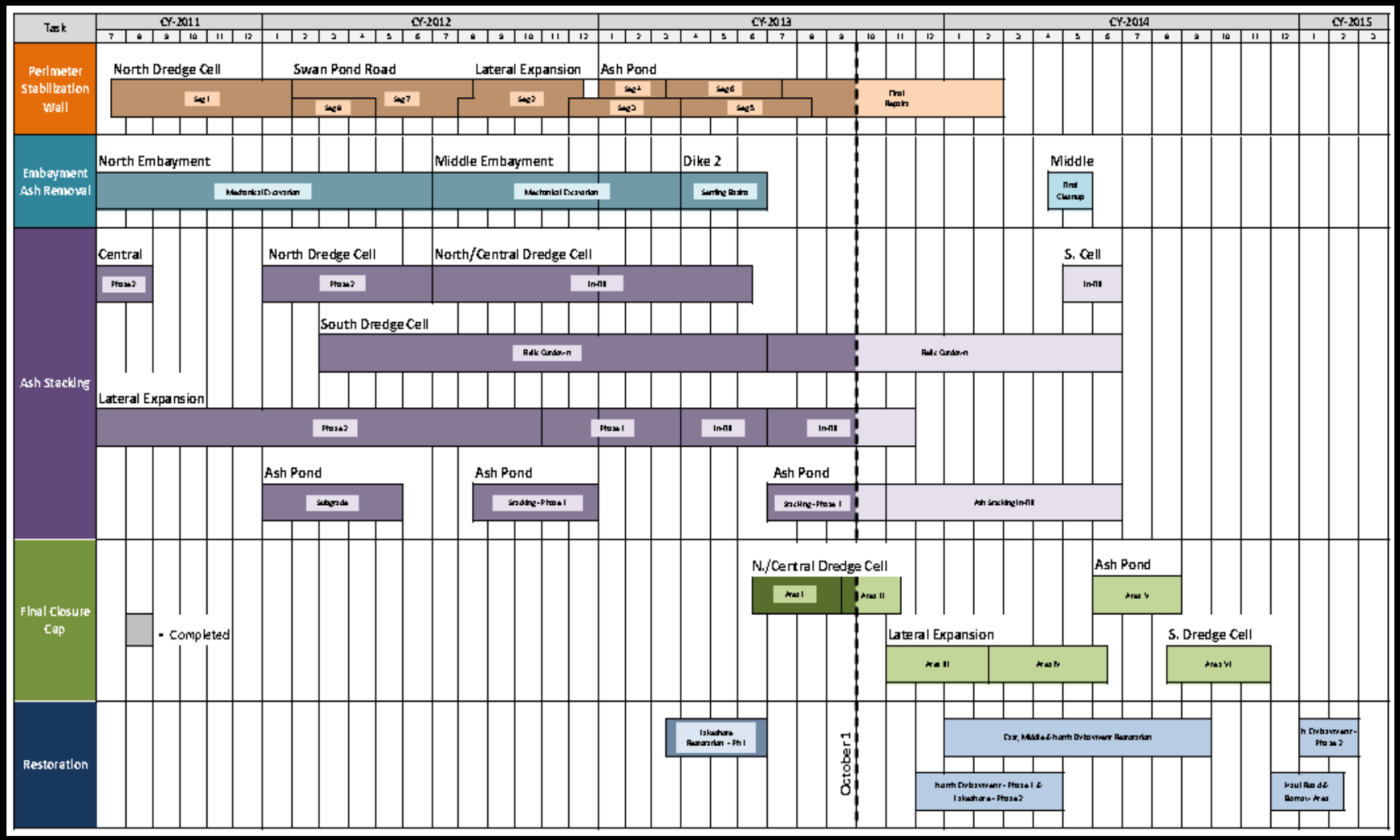
(Soil) Element	Avg. ppm	Est. lbs.
Aluminum	18,905	147 million
Iron	27,304	213 million
Copper	16	129,000
Arsenic	24	183,000
Selenium	1	8,600

Phase 2 Work Description

- Excavate Ash (Armada of Yellow Iron)
  - Pan Scrapers
  - Excavators/ar-tic dump trucks
- Short-Term Storage
  - Dry to Optimum Moisture Content
  - Lime (5% by weight)
- Long-Term Storage in Dredge Cell
  - Placed in 1 foot lifts
  - Compacted to 90% proctor
  - In-situ density/Piezos/Inclinometers
  - Final Cap & Closure
- Perimeter Containment System
- Perimeter Air & IH Monitoring
- Storm Water Mgmt & Monitoring
- Health & Safety Program

Why Moisture Content Matters

Phase 2 Operations Schedule



Mechanical Excavation

- East Embayment
  - Up to 7,500 CY/day productivity
  - 0.75 million CY excavated
  - June 2009 – May 2010 (11 months)
- North Embayment
  - Ave 5,600 CY/day productivity
  - 1.0 million CY excavated
  - November 2010 – November 2011 (13 months)
- Middle Embayment
  - Ave 2,600 CY/day productivity
  - December 2011 – June 2013 (17 months)
  - 100 % Completed (1.25 million CY excavated)

Excavation Outside of Cell Finished in Late June 2013

(3.0 million cubic yards)

Ash Stacking

- "Loose" Volumes Placed/Remaining

- Dredge Cell = 2,313,000/192,000 CYs
- Lateral Expansion = 1,890,000/Zero CYs
- Ash Pond = 375,000/615,000 CYs
- Total Ash Placed = 4,578,000 CYs
- Total Ash Remaining = 807,000 CYs
- 85% Completed

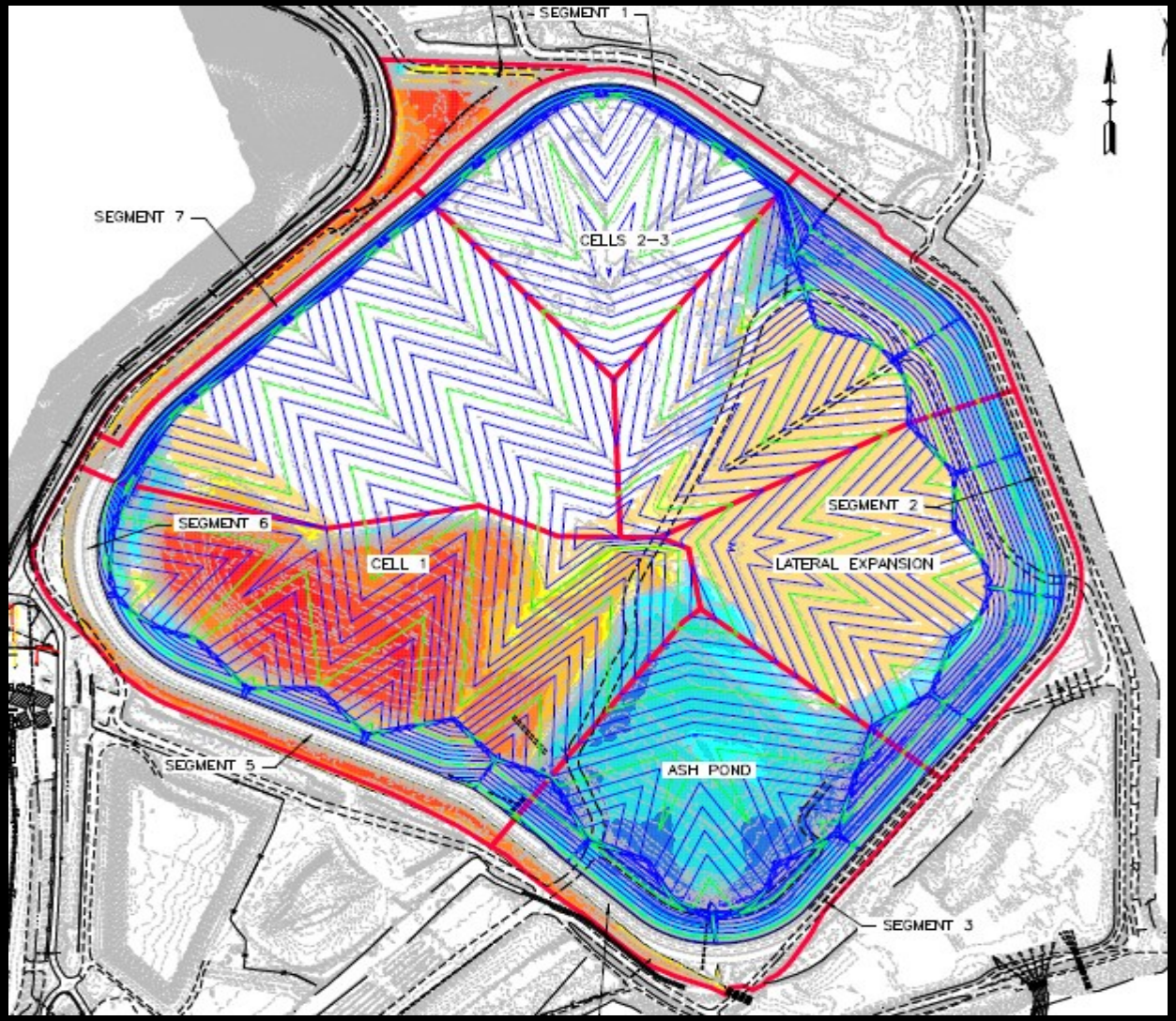
Dredge Cell Cut & Fills

Cap Design

- Prepare ash subgrade
- 40 mil HDPE liner
- Drainage layer
- 2 ft of clay/topsoil
- Vegetative surface

240 Acres Total

Cap Placement started Mid-June 2013



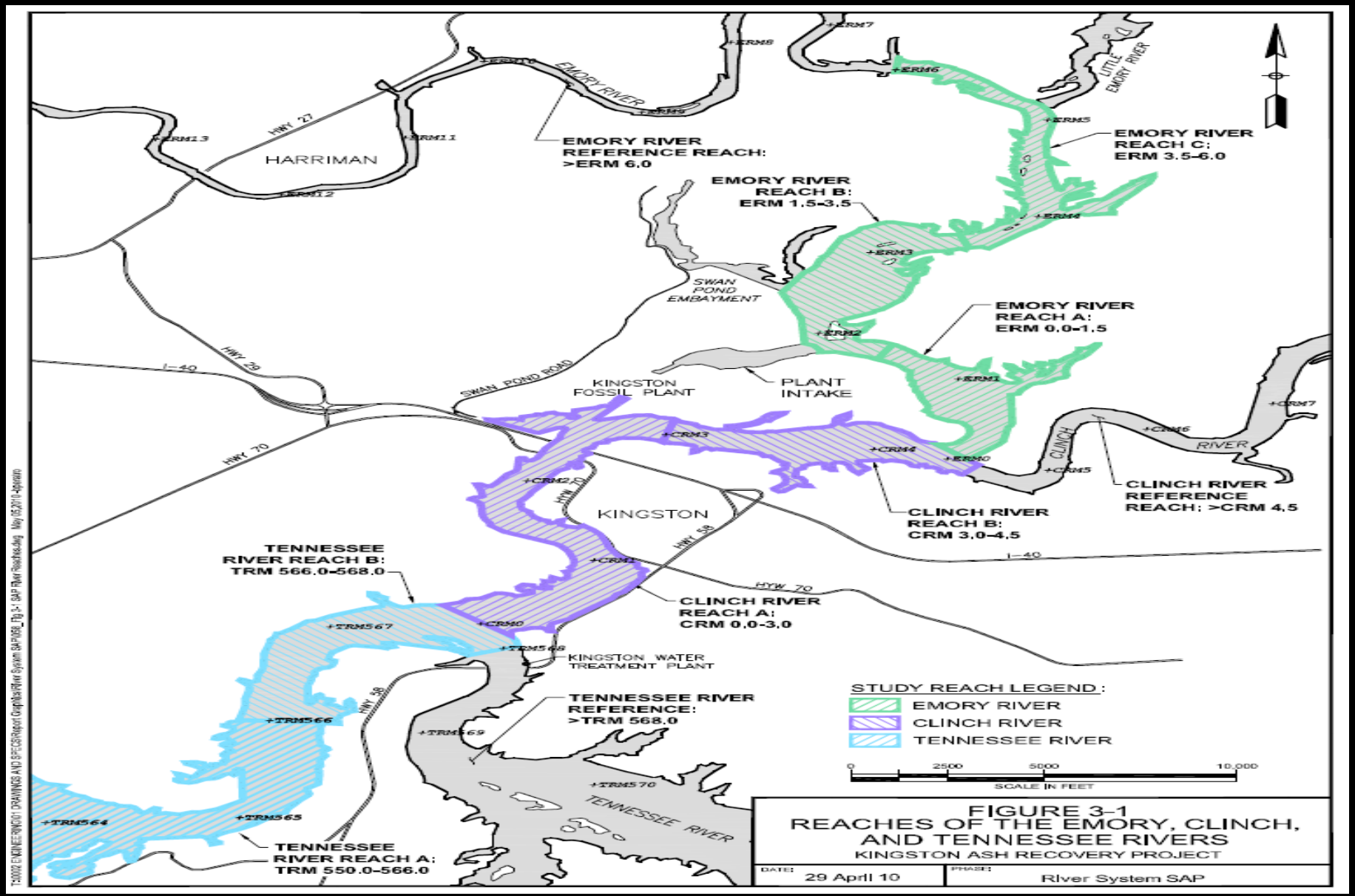
Capping Progress

- Production Goal = 2 acres per day
- 81 acres of HDPE Liner installed
- 60 acres of geo-composite drainage layer
- 56 acres of soil cover
- On schedule to be ≈50% done by end of 2013.

Perimeter Containment System

- Design based on 3-D Seismic Model (FLAC)
  - 6.0 earthquake on East TN fault
  - 7.6 earthquake on New Madrid fault
- ≈11,500 linear feet of cell perimeter
- 50-70 feet BGS/Keyed 2-6 ft into bedrock
- Target Average UCS = 280 psi
- Batch Plant for Slurry Recipe (22% blast furnace slag, 3% bentonite, 0.5% portland)
- Long stick Komatsu 1250 excavator
- 4’ wide bucket with ripper teeth
- Wall construction 100% complete 08/06/13

Phase 3 – River System SAP



Sampling & Analysis Plan – June 2010

- 2 year, $40M ecological study within CERCLA Eco Risk Framework
- >16,000 samples collected; >400,000 analyses
- Multiple State/Federal Agencies (TDEC, TWRA, USGS, USACE, ORNL, USFWS) and 10 Universities (NGOs)

ABIOTIC

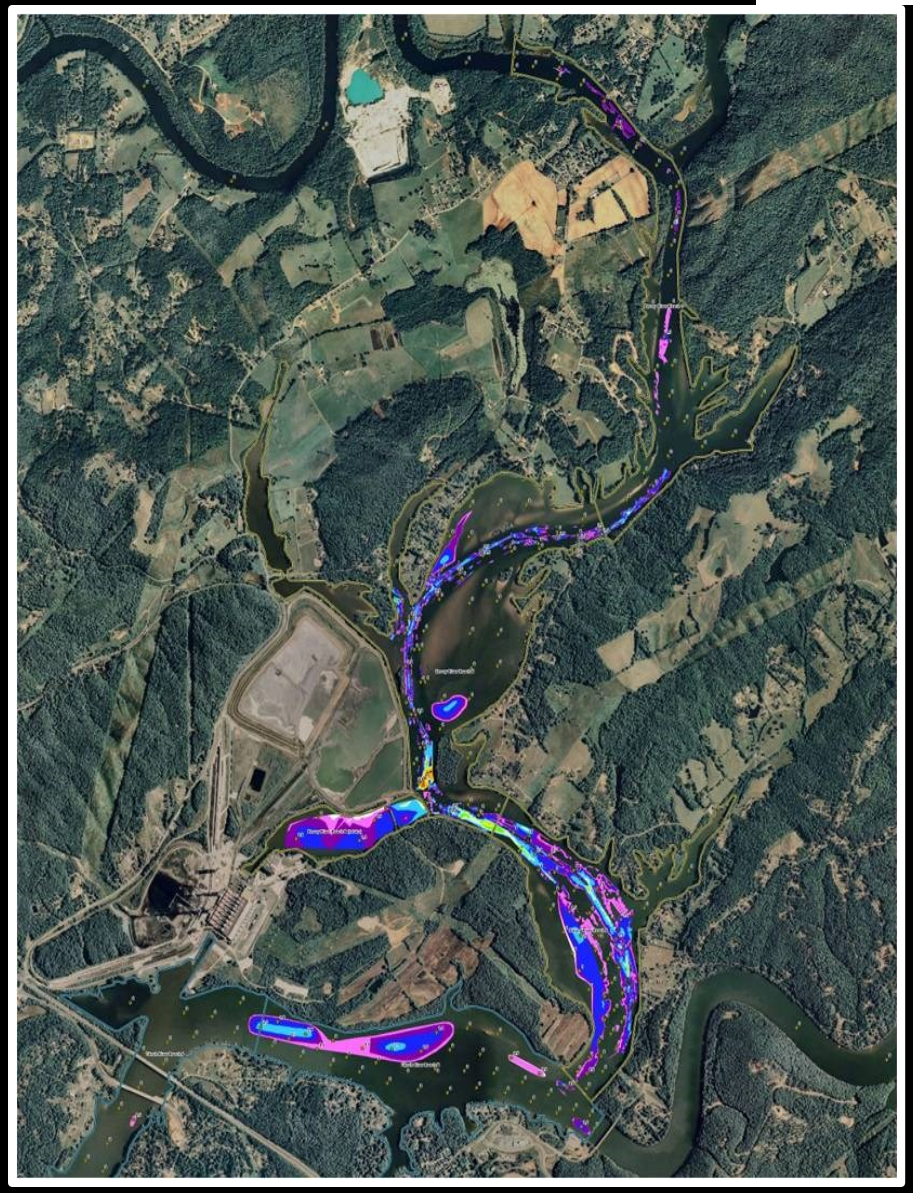
- Nature & Extent of Sediment/Ash
  - Residual ash/submerged/seasonally exposed
  - 2 Dimensional Fate/Transport Modeling
- Surface Water
- Groundwater/Aquifer Testing/MODFLOW
- Sediment Porewater & Bioassays

BIOTIC

- Fish (bass/catfish/blue gill/ gizz shad/crappie/redear sun)
- Birds (Heron/Osprey/Tree Swallows/Canada Goose)
- Amphibs (Spring Peeper/Upland Chorus/American Toad)
- Turtles (Musk/Snappers/Softshell)
- Benthic Invertebrates (Growth/Survival & Community Structure)
- Racoons
- Aquatic Vegetation & Periphyton
- Snails and Mayflies

Phase 3 River System Findings

- ≈ 510,000 CYs of residual ash dispersed over 200 acres
- Co-mingled with DOE legacy contaminants (CS-137/Hg/PCBs)
- System is Net Depositional
  - 1 to 5 feet accumulation over 30 years
  - Natural mixing/burial expected to reach sediment cleanup goals in 10 to 15 years
- Human Health Risks Acceptable
  - Confirmed need for pre-existing fish consumption advisories
- Moderate to Low Ecological Risks
  - Limited to Laboratory Sediment Toxicity tests for *H. Azteca* and *C. Dilutus* (survival/growth)
  - SE & AS accumulation Larval/Adult Mayflies
  - Potential food chain risks for birds that prey on those bugs (killdeer/tree swallows)
  - Benthic abundance and diversity similar at all study sites



Removal Alternatives Evaluated - August 2012 EE/CA Report

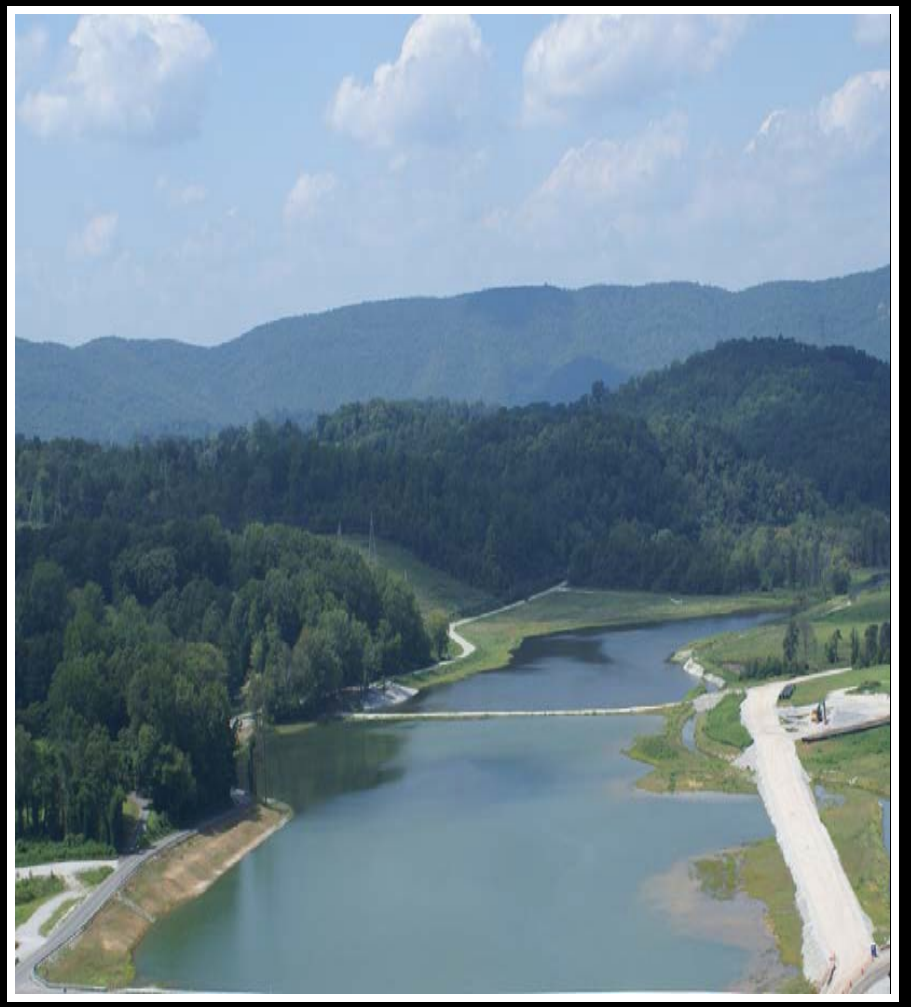
- Alternative 1 - Monitored Natural Recovery (MNR)
  - 30 years of monitoring for sediment, mayflies, benthic/fish communities and sediment transport modeling
  - Net Present Value = $10 Million
- Alternative 2 – Capping
- Alternative 2A
  - Cap all 200 acres (150 acres pea gravel + 50 acres medium sized)
  - Net Present Value = $45 Million
- Alternative 2B
  - Cap 160 erosion prone areas (110 acres pea gravel + 50 acres medium sized)
  - Net Present Value = $39 Million
- Alternative 3 – Additional Dredging
- Alternative 3A – 440,000 CYs > 1 foot thick
  - 130,000 CYs ($35/ton) + 310,000 Cys (low level rad @$312/ton)
  - Net Present Value = $179 Million
- Alternative 3B – 160,000 CYs in ecological significant area (shallows)
  - 30,000 CYs ($35/ton) + 130,000 CYs (low level rad @$312/ton)
  - Net Present Value = $84 Million

Community Involvement

- Conducted series of 6 workshops at Roane State CC (March – June 2012
- River System EE/CA Report (HHRA + BERA) released for public comment on 08/10/12
- Initial 30 day comment period extended 30 days to 10/12/12
- Phase 3 River System Action Memo for Alternative 1 – MNR approved by EPA & TDEC on 11/07/12
  - MNR remedy consistent with moderate to low eco risk
  - Capping and Dredging alternatives did not significantly reduce time required to meet objectives considering additional NPV
  - Dredging and disposal of co-mingled DOE legacy contaminants complicates matters
  - Consistent with 2 Records of Decision (RODs) issued by DOE for Clinch River and Lower Watts Bar Reservoir
  - Generally supported by community
- Long Term Monitoring Plan Approved May 2013
  - Monitoring starts Spring 2013

North Embayment

then



now

East Embayment

then

now

Swan Pond Embayment Restoration

Swan Pond Embayment Restoration

- **Phase 1 – Lakeshore Park**
  - **Completed August 2012**
  - **Walking trails, fishing piers, courtesy docks & restroom facilities**
- **Phase 2 – Lakeshore Park/Middle Embayment**
  - **Boat ramp, walking bridge, trails & Middle Embayment habitat improvements underway**
  - **Berkshire Recreation Area at completion of project**

A Long Ash Day Ahead!

- 14 technical presentations by a variety of *distinguished* guests
- Fish Health & Reproduction
- Human Health Risk Assessment
- Sediment Toxicity
- Mayflies
- Benthic Macro Invertebrates
- Selenium
- Ecological Risk Assessment/Remedial Goals
- Wildlife Exposure/Dietary Models
- Long Term Monitoring Plan
- NRDA
- Discussion